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NATF-EN-1095

THE EFFECT OF DECK SPAN
UPON ARRESTING-GEAR PERFORMANCE
(2 June 1964 through 18 March 1966)

Final Report
24 April 1967

by

W. Billec
Shipboard Recovery Branch

Prepared under Naval Air Systems Command
Work Unit Number AIR-5373-211/204/1

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ABSTRACT

Tests were conducted to determine the effect of different deck spans upon arresting-gear performance. Using 10,000-, 25,000-, and 50,000-pound deadloads--each at nominal engaging speeds--and deck spans of 100, 115, and 130 feet, 80 arrestments were conducted. In addition, combinations of two engine cams and sheave-damper orifices were utilized.

Lower maximums for the arresting-hook axial load and cable deck-tension parameters were generally recorded with the longer deck spans--particularly the 130-foot span. Changes in the cams appeared to have no effect on the loads.

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I INTRODUCTION

Tests were authorized by the Naval Air Systems Command under Weptask RS-11-50-007/204/1/3-416-80-05 Problem Assignment No. RSSH-03-125/204/1, to detect differences in Mark 7 Mod 1 arresting gear performance with deck spans of 100, 115, and 130 feet. The Naval Air Test Facility (Ship Installations) (NATF(SI)), U. S. Naval Air Station, Lakehurst, New Jersey, conducted 80 deadload arrestments during the period 2 June 1964 to 18 March 1966 at Recovery Systems Track Site (RSTS) No. 2.

II ARRESTING-GEAR CONFIGURATION

A Mark 7 Mod 1 arresting gear was configured as follows:

Cam - K-5, PN 502715-1P
K-6, PN 502715-2P

Cam torque - 90 ± 20 foot-pounds

Cam chain-drive pre-tension - 400 ± 10 pounds

Arresting engine ratio dial - NAEL(SI) PN 316152-1

Sheave damper accumulator prepressure - 750 ± 25 psi

Buffer accumulator prepressure - 300 ± 25 psi

Damper accumulator flapper valve orifice - 3/8-inch-diameter

Buffer accumulator flapper valve orifice - 1/2-inch-diameter

Orifice diameter in operating end - 2 and 2-1/2 inches

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III TEST CONDITIONS AND PARAMETERS RECORDED

A. Test Conditions: Eighty arrestments were conducted under the conditions summarized below:

No. of Arrestments	Nominal Deadload Weight (Pounds)	Engaging-Speed Range (Knots)	Deck Span (Feet)	Constant-Runout-Valve Cam (Type)	Orifice Diameter (Inches)
15	10,000	74.7 - 120.8	100	K-5	2½
5	25,000	83.4 - 117.9	"	"	"
3	50,000	103.5 - 113.0	"	"	"
3	10,000	99.0 - 121.3	"	K-6	2
4	25,000	102.0 - 123.8	"	"	"
4	50,000	100.7 - 115.2	"	"	"
4	10,000	102.1 - 120.8	115	K-5	2½
3	25,000	102.1 - 123.3	"	"	"
5	50,000	103.1 - 114.7	"	"	"
3	10,000	103.1 - 120.8	"	K-6	2
5	25,000	97.4 - 122.8	"	"	"
3	50,000	102.8 - 115.2	"	"	"
3	10,000	103.9 - 119.8	130	K-5	2
3	25,000	103.9 - 121.3	"	"	"
3	50,000	100.0 - 115.2	"	"	"
4	10,000	96.1 - 120.3	"	K-6	"
6	25,000	78.5 - 154.2	"	"	"
4	50,000	101.4 - 113.0	"	"	"

B. Parameters Recorded: The following parameters were recorded:

1. Arresting gear cable deck tension vs time
2. Arresting gear cable anchor tension vs time
3. Arresting-gear-engine cylinder pressure vs stroke
4. Arresting-gear-engine cylinder pressure vs time
5. Arresting-gear-engine ram stroke vs time
6. Arresting-hook axial load vs time
7. Deadload longitudinal deceleration vs time
8. Sheave damper cylinder pressure vs time

IV TEST RESULTS AND ANALYSIS

A. General: The primary effect of a change in the deck span is a phase shift in the oscillatory loads of the arresting system. Examination of the time histories confirms this result. The longer the deck span, the later in the arrestment the following maximums occurred: cable tension, longitudinal deceleration, and arresting-hook axial load. The maximum loads are plotted versus engaging speed, and the results are observed in an effort to detect trends among the deck spans.

B. Cable Deck Tension: The timing of the sheave impact tension and its subsequent reflections are expected to be affected by the length of the deck span.

1. Figure 1 is a plot of some representative times when sheave impact occurred with deck spans of 100, 115, and 130 feet. No distinction is made for deadload weight. As expected, sheave impact occurred later with the longer deck spans, but the timing was little affected by the engaging speed.

2. The magnitude of sheave impact tensions are comparable as may be seen in Figure 2: these tensions for the three spans lie approximately in the range of 40,000 to 75,000 pounds.

3. Figure 3 is a plot of maximum cable tension versus engaging speed for the 10,000-pound deadload for all three deck spans. These tensions are sheave impact tensions and no difference is detected among the spans.

4. Figure 4 is a plot of maximum cable tension versus engaging speed for the 25,000- and 50,000-pound deadloads for all three deck spans. Tension data with the longer deck spans tends to cluster near the lower boundary of the scatter.

No effect of the engine cam is readily discernable among the deck spans, deadload weights, or engaging speeds.

C. Longitudinal Deceleration: The longitudinal decelerations were affected by the deck span--particularly for the 10,000-pound deadload arrestments.

1. Figure 5 contains plots of longitudinal deceleration for 10,000-, 25,000-, and 50,000-pound deadload arrestments using both cams and all three deck spans.

- a. The plots indicate significantly lower decelerations with the 130-foot deck span and the 10,000-pound deadload. A part of this deceleration difference is attributed to the heavier deadload weight (10,700 pounds for 130-foot deck-span tests versus 9,900 pounds

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for the 100- and 115-foot deck-span tests), but the greater part is probably the result of the deceleration timing induced by the longer deck span.

b. The decelerations for the 25,000- and 50,000-pound deadloads failed to indicate a difference, among spans, approaching that found with the 10,000-pound deadload. Virtually no difference is detected with the 50,000-pound deadload, but the 25,000-pound deadload data seem to indicate a tendency to a lower deceleration with the longer deck span.

c. There is no readily discernable effect of the engine cam.

2. Figure 6 contains time histories contrasting the differences in typical 10,000- and 25,000-pound deadload arrestments with 100- and 130-foot deck spans. For both weight deadloads, a phase shift caused by the 130-foot deck span, is evident and is accompanied by lower peak decelerations.

D. Arresting-Hook Axial Load: Figure 7 contains plots of maximum arresting-hook axial loads for 10,000-, 25,000-, and 50,000-pound deadload arrestments using both cams and all three deck spans. In all cases, the 130-foot deck-span data tends to be lower, but the 10,000-pound deadload (with a 130-foot deck span) produced the greatest difference. Maximum longitudinal decelerations support this result. There is no readily discernable effect of the engine cam on this parameter.

E. Engine-Cylinder Pressure: Figure 8 contains plots of maximum engine-cylinder pressure versus engaging speed for 10,000-, 25,000-, and 50,000-pound deadload arrestments using both cams and all three deck spans. The effect of deck span upon this parameter is not apparent in the test scatter: the effect of the K-6 cam appears significant for the 25,000- and 50,000-pound deadload data. Although the increased lift of the K-6 cam apparently generates higher cylinder pressures, the increase did not impose performance limitations.

F. Engine Ram Stroke: Figure 9 contains plots of maximum engine ram stroke versus engaging speed for all three deadload weights tested. All ram strokes are within acceptable performance limits.

G. Cable Anchor Tension: Figure 10 contains plots of maximum port and starboard cable anchor tension for 10,000-, 25,000-, and 50,000-pound deadload arrestments using both cams and all three deck spans. All data is within acceptable limits.

H. Sheave-Damper Piston Stroke, Piston Velocity, and Cylinder Pressure: Plots of these three parameters are contained in Figure 11 for the 10,000-pound and in Figure 12 for the 25,000- and 50,000-pound deadload arrestments using both cams and all three deck spans. In addition, in Figure 12, a flag appears on those symbols that indicates starboard parameters. A review of these figures reveals:

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1. Maximum stroke and velocity were lower with the 2-inch-diameter orifice ring when using the 10,000-pound deadload, and with the 130-foot deck span when using the 25,000- and 50,000-pound deadloads. This tends to indicate that maximum cable deck tensions were lower with the 130-foot span as seen in the discussion of cable deck tensions.

2. The effect of orifice-ring diameter with the 25,000- and 50,000-pound deadloads cannot be detected because data is sparse.

3. Maximum cylinder pressures exhibit no important variance among the three deck spans.

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V CONCLUSIONS

A. Increasing the deck span had the effect of causing lower dynamic loading with all deadload weights; however, the most pronounced change was with the lightweight (10,000-pound) deadload.

B. The two engine cams used had no discernable effect upon the maximum cable tension, arresting-hook axial load, and longitudinal deceleration parameters; for small variations in deck span, it is not necessary to change the constant-runout-valve cam.

VI RECOMMENDATIONS

A. The maximum permissible deck span should be utilized for Mark 7 Mod 1 arresting-gear installations.

B. A single cam for ± 5 -foot variations in deck spans of the Mark 7 Mod 1 arresting gear should be utilized.

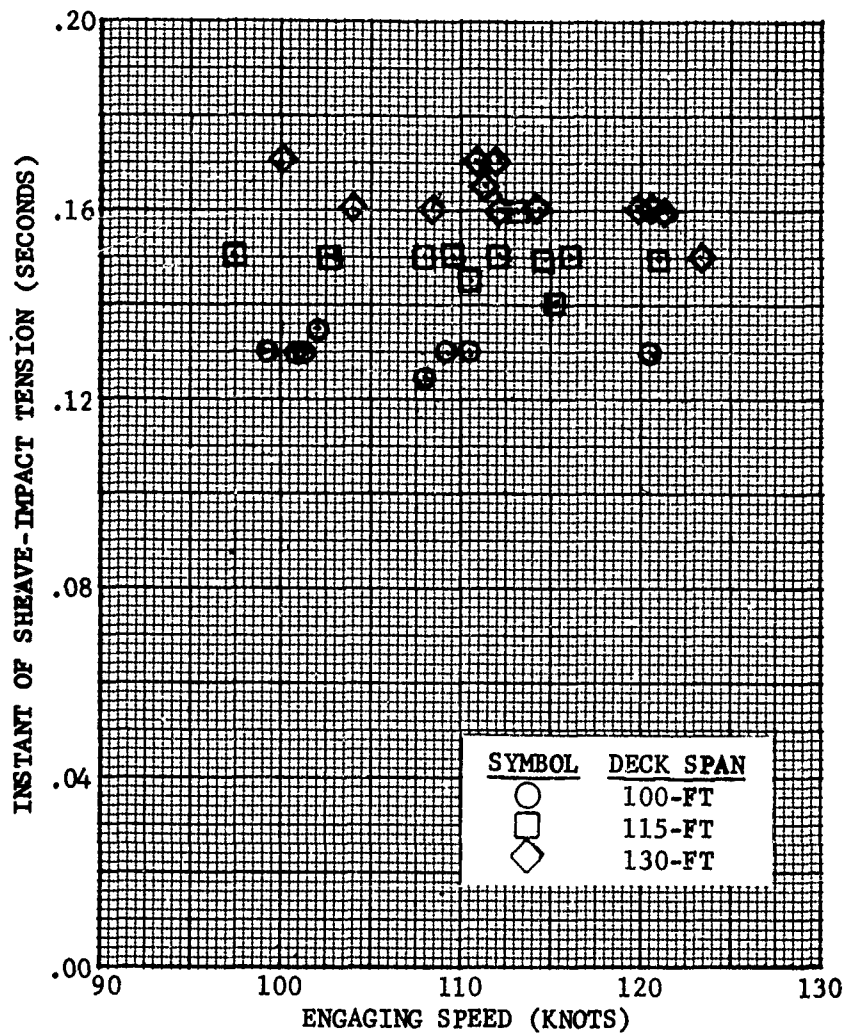


Figure 1 - Instant of Sheave Impact versus Engaging Speed for 100-, 115-, and 130-Foot Deck Span

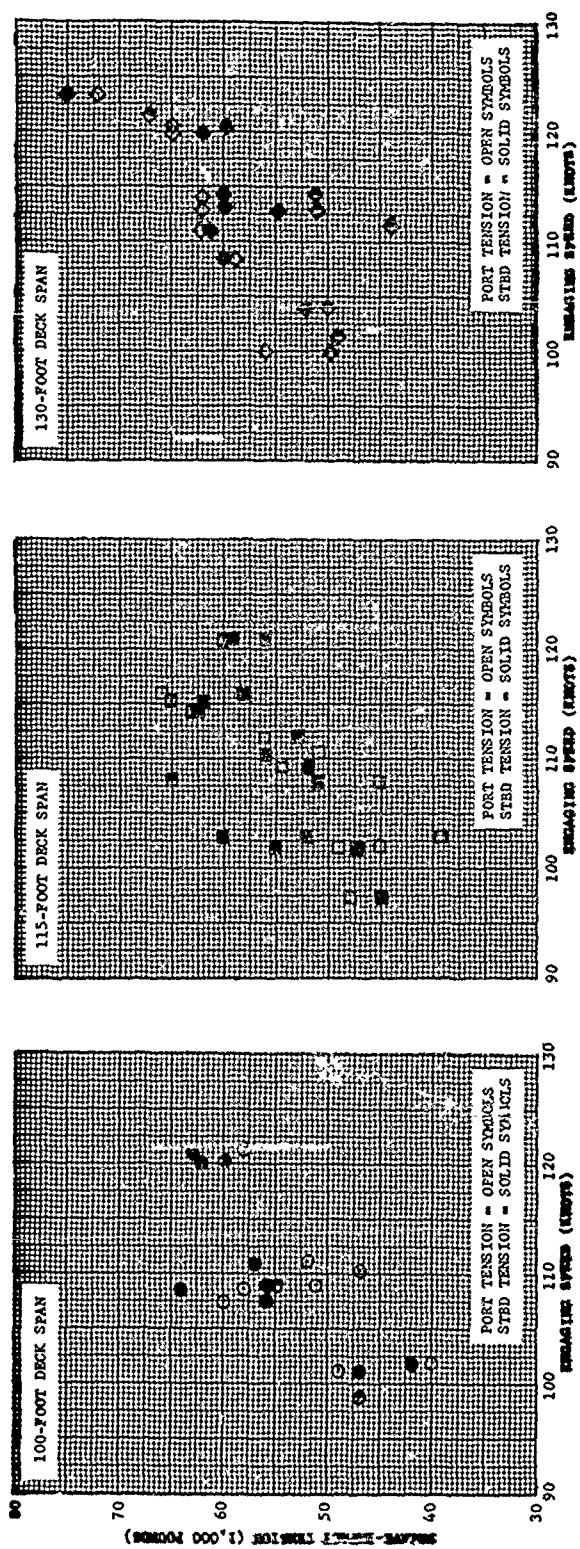


Figure 2 - Sheave-Impact Tension versus Engaging Speed of 10,000-, 25,000-, and 50,000-Pound Deadloads (100-, 115-, and 130-Foot Deck Spans)

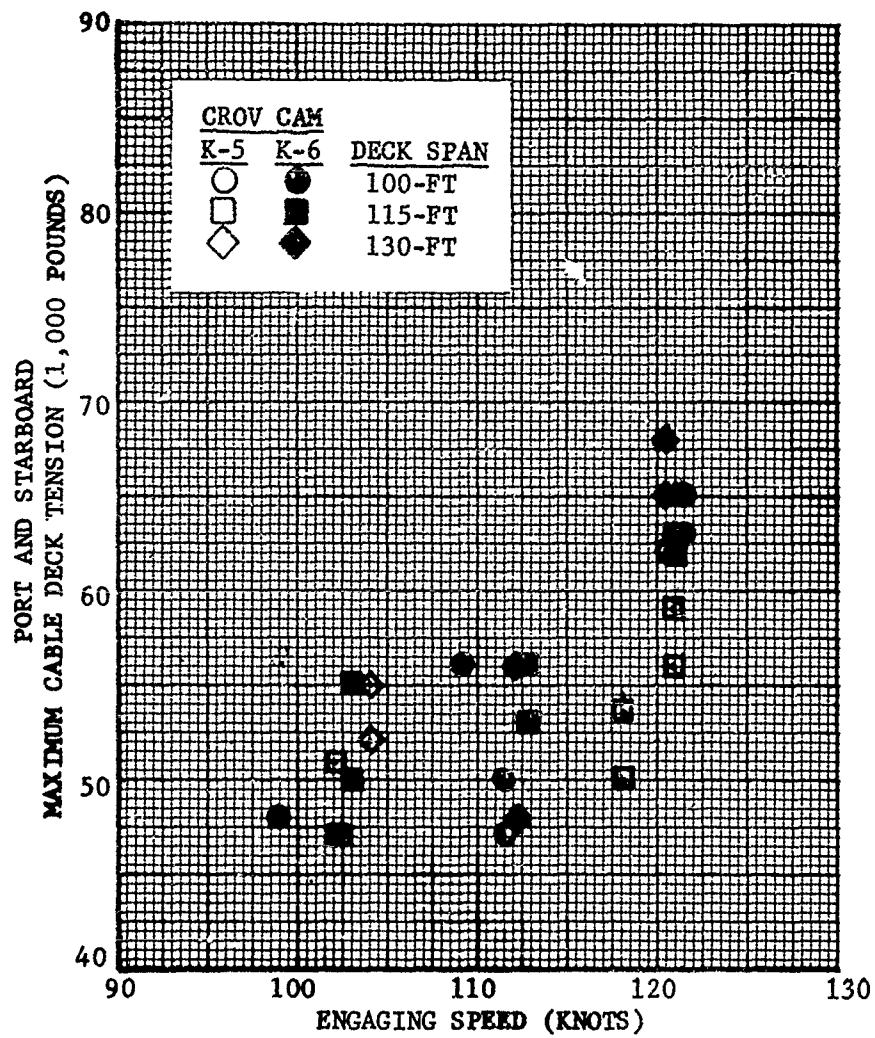


Figure 3 - Port and Starboard Maximum Cable Deck Tension versus Engaging Speed for the 10,000-Pound Deadload for All Three Deck Spans

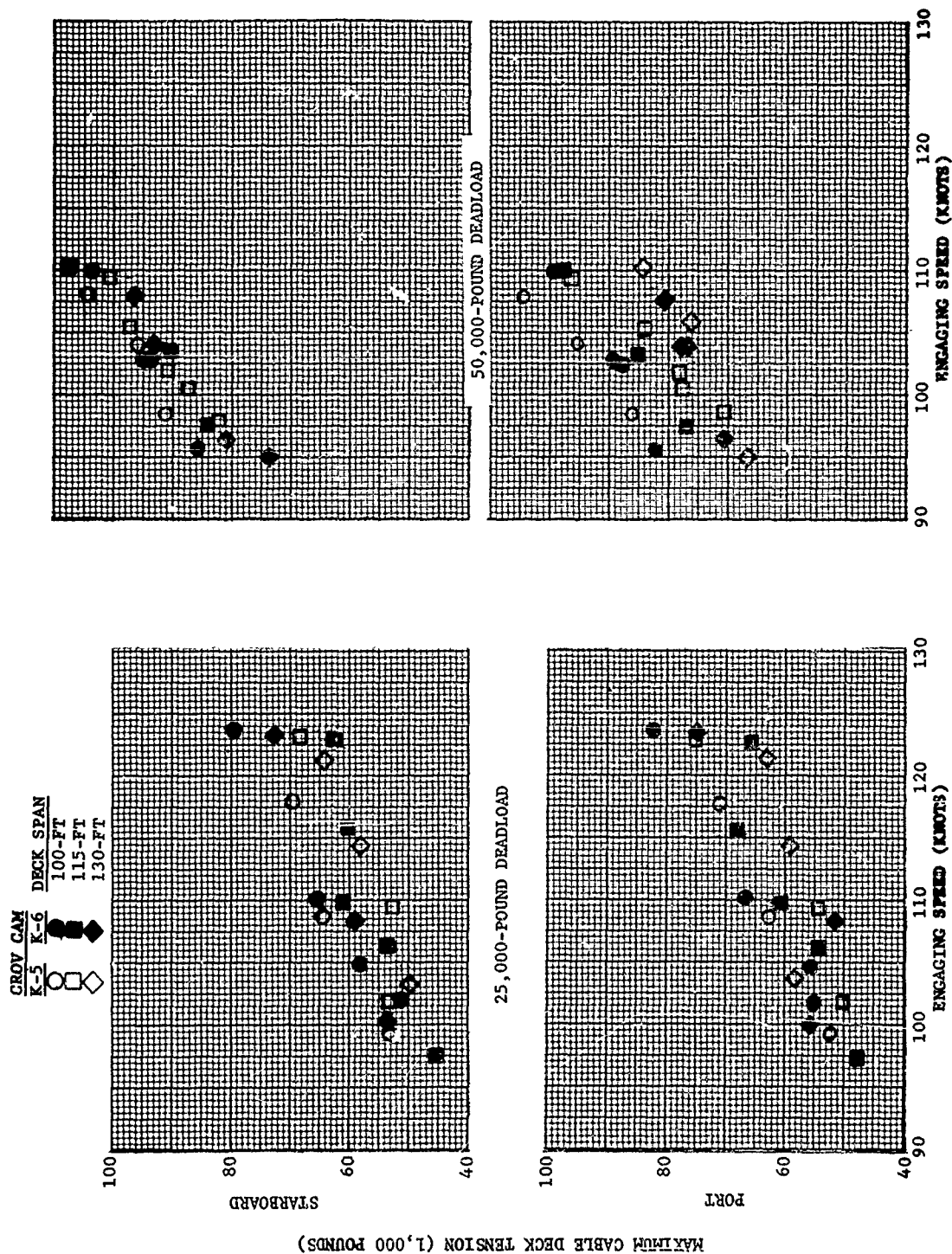


Figure 4 - Port and Starboard Maximum Cable Deck Tension versus Engaging Speed for 25,000- and 50,000-Pound Deadloads for All Three Deck Spans

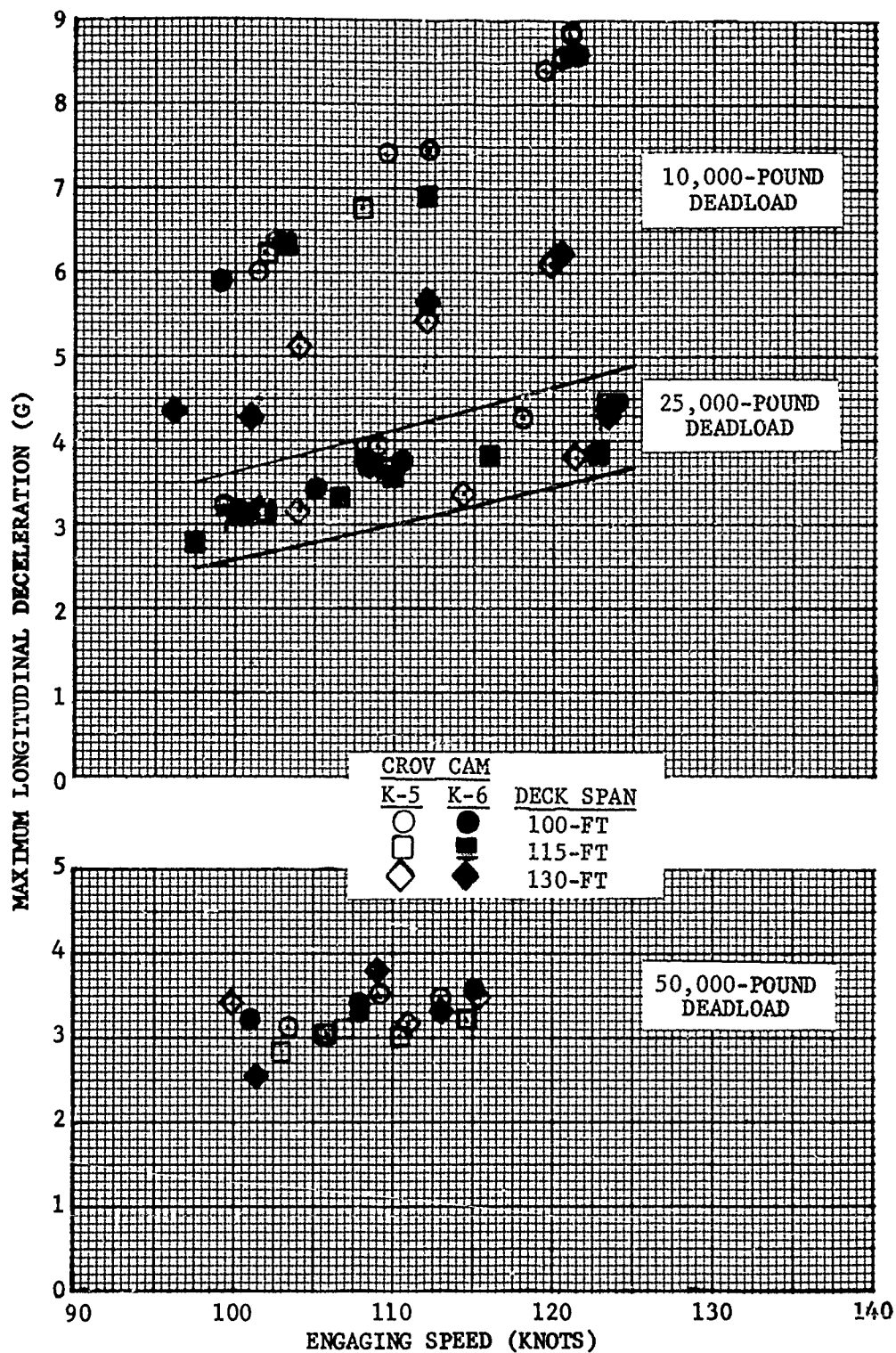


Figure 5 - Maximum Longitudinal Deceleration versus Engaging Speed for 10,000-, 25,000-, and 50,000-Pound Deadloads

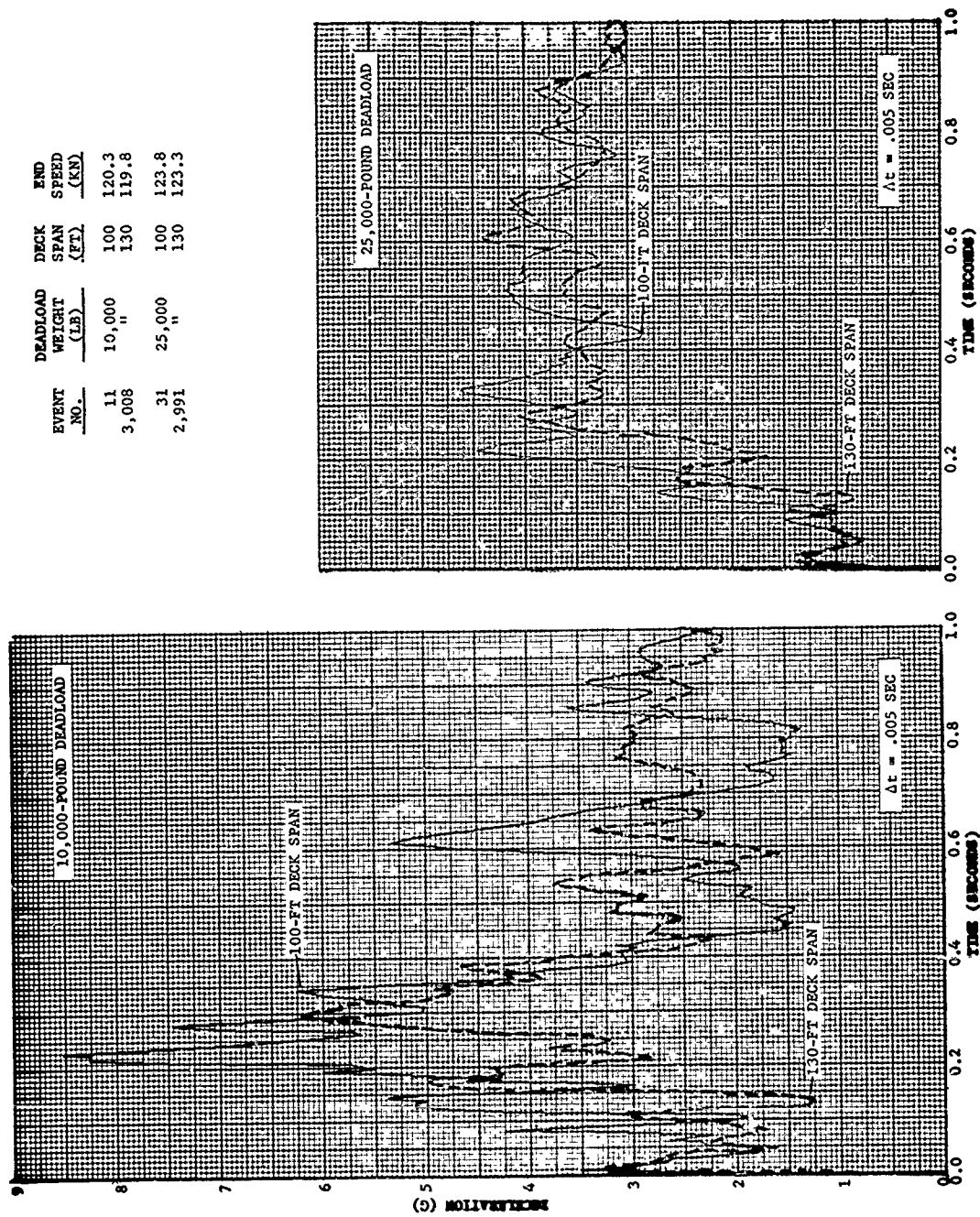


Figure 6 - Deceleration Time Histories versus Time for 10,000- and 25,000-Pound Deadloads Using 100- and 130-Foot Deck Spans

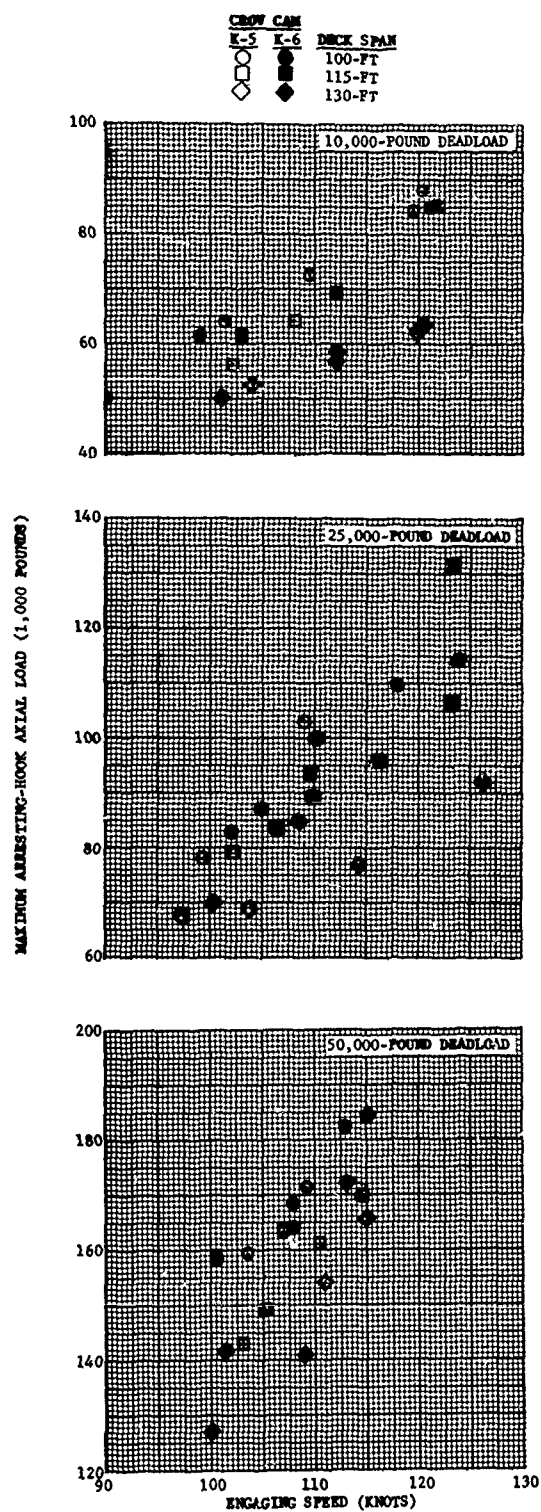


Figure 7 - Maximum Arresting-Hook Axial Load versus Engaging Speed for 10,000-, 25,000-, and 50,000-Pound Deadloads Using 100-, 115-, and 130-Foot Deck Spans

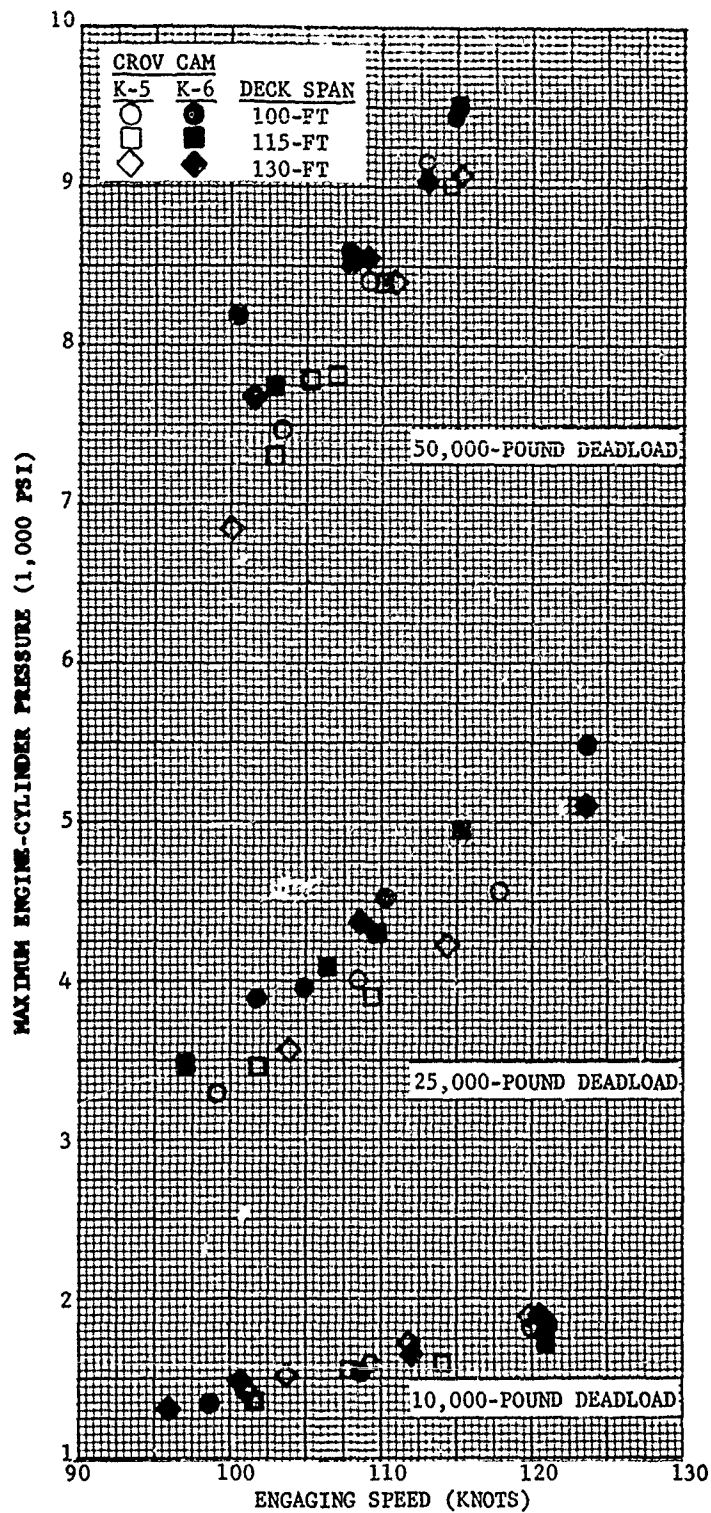


Figure 8 - Maximum Engine-Cylinder Pressure versus Engaging Speed
for 10,000-, 25,000-, and 50,000-Pound Deadloads
Using 100-, 115-, and 130-Foot Deck Spans

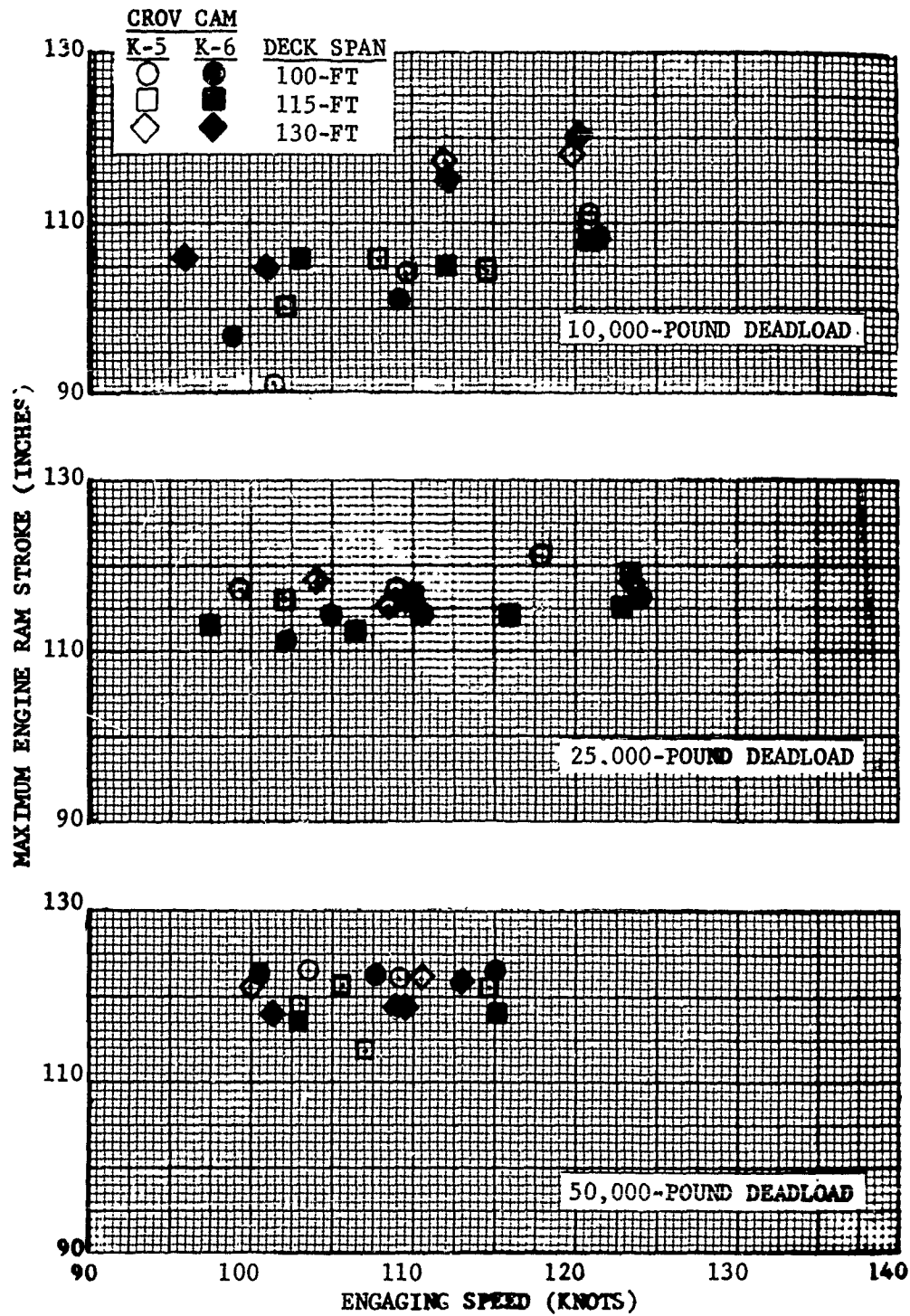


Figure 9 - Maximum Engine Ram Stroke versus Engaging Speed for 10,000-, 25,000-, and 50,000-Pound Deadloads Using 100-, 115-, and 130-Foot Deck Spans

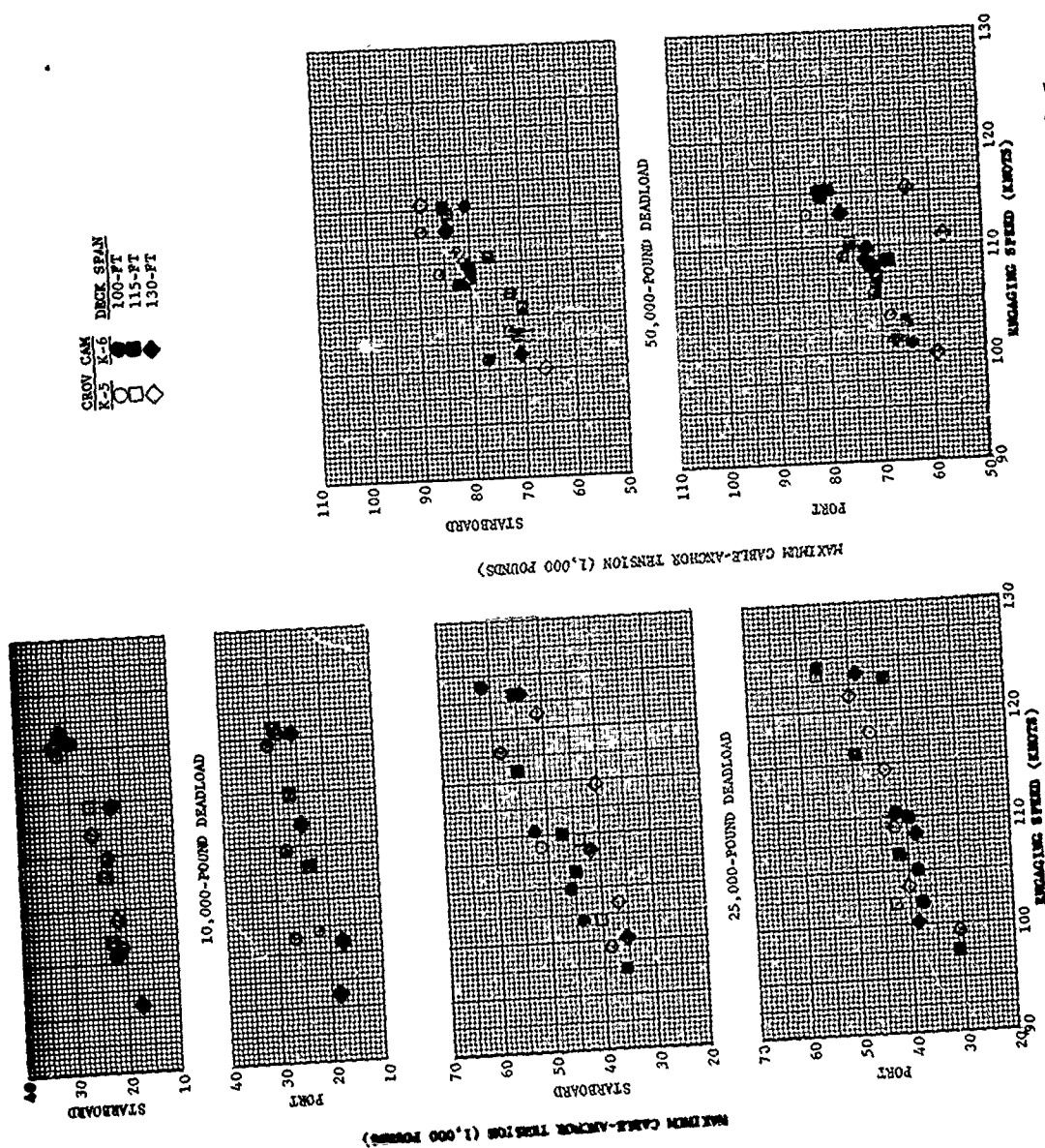


Figure 10 - Maximum Cable-Anchor Tension versus Engaging Speed for 10,000-, 25,000-, and 50,000-Pound Deadloads Using 100-, 115-, and 130-Foot Deck Spans

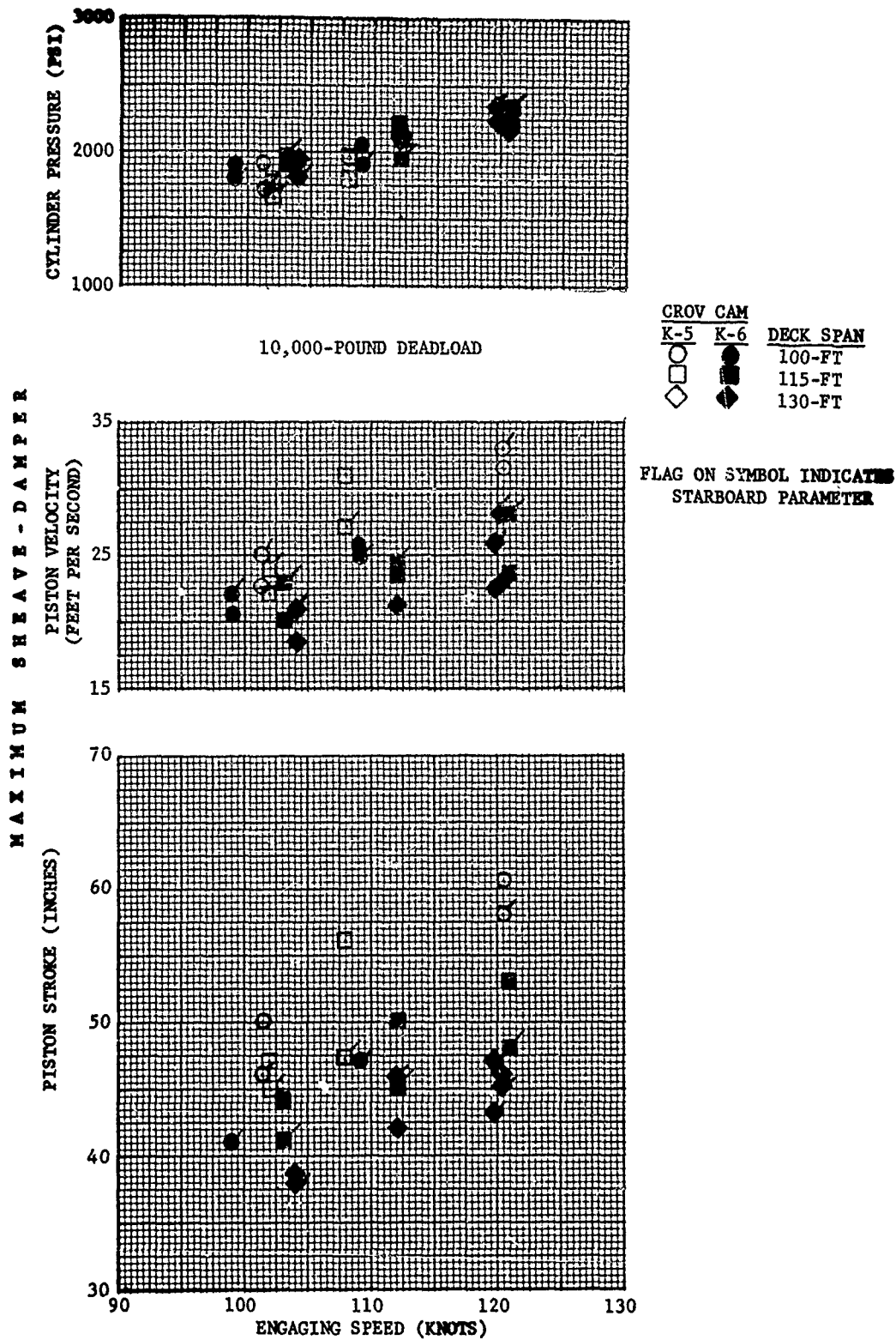


Figure 11 - Maximum Sheave-Damper Cylinder Pressure, Piston Velocity, and Piston Stroke for 10,000-Pound Deadloads Using 100-, 115-, and 130-Foot Deck Spans

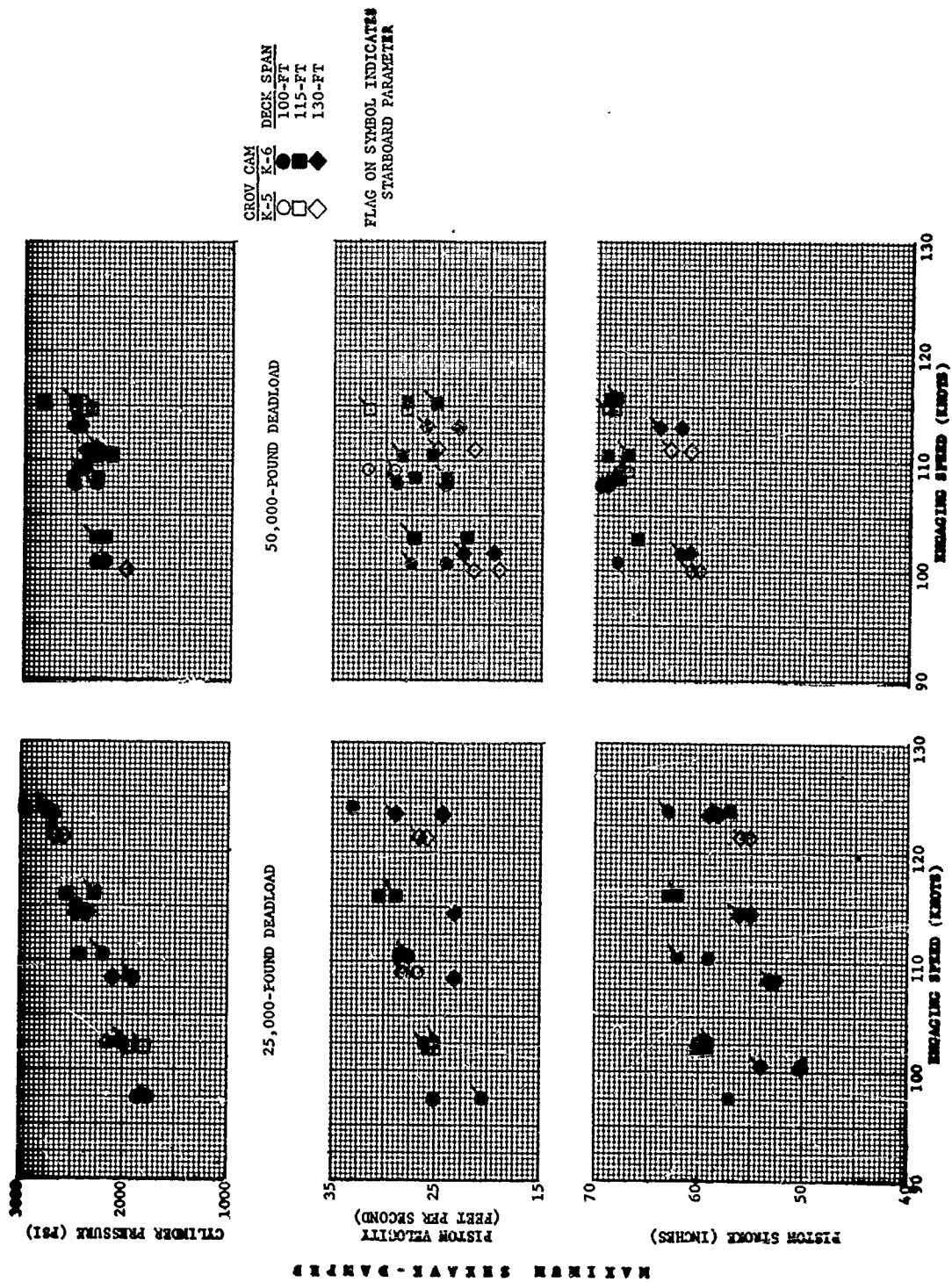


Figure 12 - Maximum Sheave-Damper Cylinder Pressure, Piston Velocity, and Piston Stroke for 25,000- and 50,000-Pound Deadloads Using 100-, 115-, and 130-Foot Deck Spans

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